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Recommendations for the selection of city case studies for the IPCC SR on Cities

Scope and objectives. We developed a global typology that groups cities based on shared characteristics—such as population size, growth, density, and infrastructure. Our typology is linked to the urban case study literature, which we attributed to the specific cities in our typology (based on an updated database of urban case studies outlined in Montfort et al., 2025) – to our knowledge, the most comprehensive database currently available. Importantly, our typology does not directly incorporate characteristics related to climate change mitigation, adaptation, or impacts. There are two reasons for this: First, treating mitigation and adaptation as *outcomes* of the typology enables analysis of what drives climate action, rather than embedding those outcomes within the typology itself. Second, global urban datasets like GHSL UCDB, which are accepted for intergovernmental bodies like the IPCC, provide uneven coverage of climate hazards; including these indicators would reduce the quality and consistency of the typology, or bias it toward more data-rich contexts with fewer missing values – typically cities in the global north.

We emphasize that our proposed set of case studies is a recommendation, not a fixed list. It aims to support authors in identifying cities that are relevant, diverse, and representative—not just in terms of geography and population, but also by capturing key urban development pathways rooted in the typology. This recommendation is by our global database of climate-related studies and case studies. Although very comprehensive, this does not mean that our database is perfect and devoid of any gaps, but we did try our best to get a comprehensive and relevant sample of the urban climate change literature by checking the inclusion of papers we knew to be relevant.

The objectives of this recommendation are to:

1. Help the IPCC community identify relevant and diverse types of cities.
2. Help provide access to a pre-processed database of urban case studies linked to these diverse cities.
3. Improve the representativeness of selected cases of the IPCC report, a) regarding the different *urban development pathways* emerging from the characteristics of the cities, b) geographically by world region, and c) by population size.

To access our database, please use the Excel file, read the description in the “read me” sheet, which explains how to use the case selection sheet and the case study literature database.

Types of cities. Cities were grouped into four main types (or "clusters") based on how they align with different patterns of climate and development priorities (Fig. 1): Development First (cities with lower emissions but urgent development needs),): Mitigation First (cities with high emissions and strong potential for mitigation), Urban Planning First (where infrastructure and governance shape the urban response), and Megacities All In (large global cities with complex, cross-cutting challenges). We used a computational machine learning approach called Deep Embedded Clustering, which groups cities based on latent features in the data that may be difficult to see otherwise. We used this method because it leads to vast performance gains

compared to other, more traditional methods. Each city has been assigned to the type it most consistently matched across multiple models, ensuring that grouping of cities into distinct types reflects stable patterns—not just statistical noise. This means that each city can share characteristics of different types. For instance, a few cities in central Africa are predominantly in the Mitigation first type (Fig. 1b), but share important characteristics with other types (indicated by the lighter colors), like Development First and Urban Planning First.

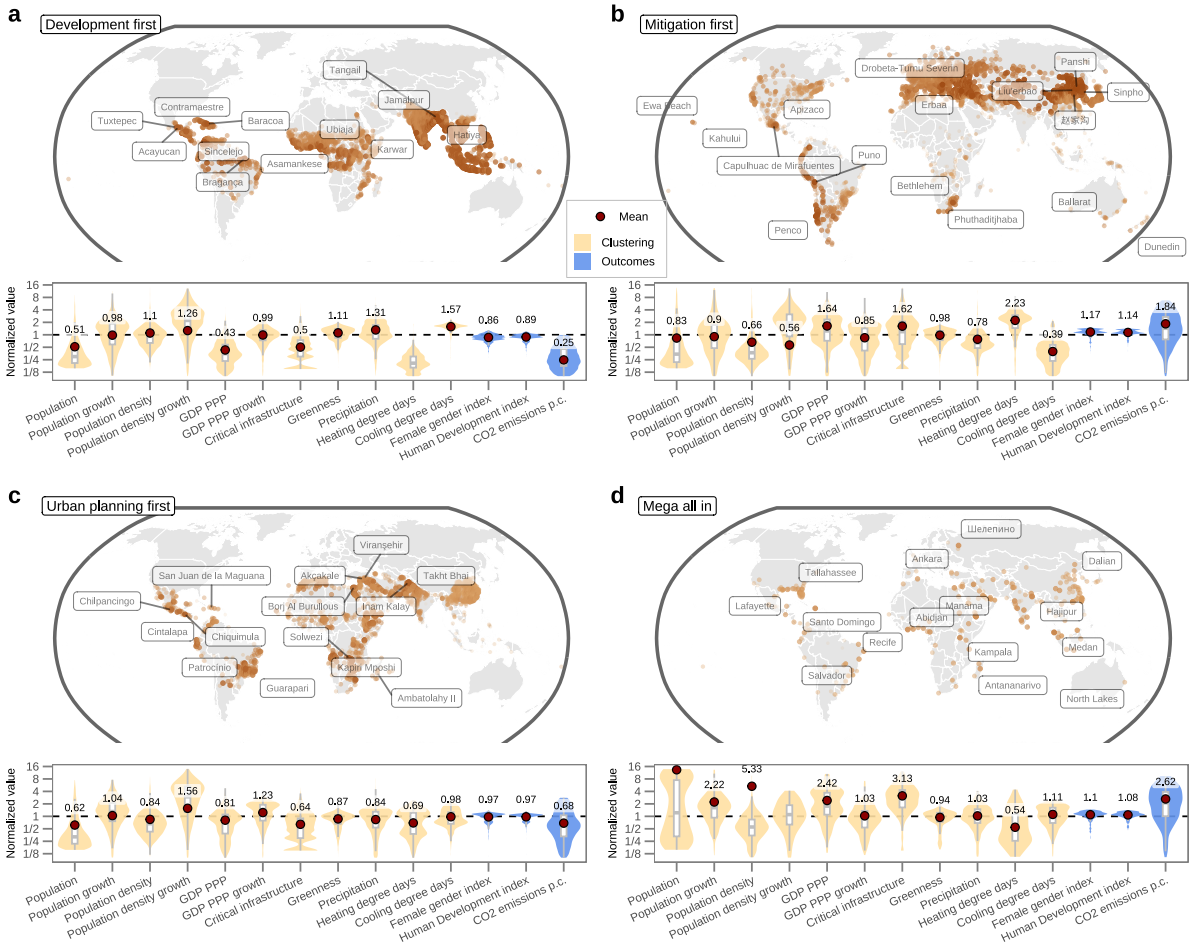

Fig 1: The four city types in the typology. Panel (a) shows Development First, (b) Mitigation First, (c) Urban Planning First, and (d) Megacities All In. Each dot represents a city, colored by how consistently it was assigned to the main type across 30 clustering runs. Darker colors indicate stronger alignment with that type, while lighter colors suggest overlap with other types. The box plots summarize the distribution of key variables (with outliers and negative values excluded for better visibility). Red dots indicate the mean, and the numeric labels show how each type compares to the overall mean—for example, a value of 1.1 means the average city of that type is 10% above the global mean of that variable.

Need for a structured case selection. Using a systematic approach to the selection of the cities is important for several reasons: First, the IPCC report should be balanced and comprehensive to provide actionable insights for urban practitioners across the world. Hence, only if the IPCC report adequately represents all types of cities across the world can it have the biggest impact. Second, the literature has its own biases and tends to overrepresent larger cities, while many small and fast-growing cities remain invisible (Montfort et al., 2025). Simply

reflecting the existing literature could skew the IPCC's conclusions and fail to capture the full diversity of urban experiences.

While we do advocate for structured case selection, a perfectly proportional representation may neither be feasible nor warranted. But we hope to enable a conscious decision about which regions and which types of cities will be represented in the report, by making visible how much evidence is available for what types of cities to support the best possible IPCC expert reviewing process.

Selection Criteria and Process. Our recommendation for the case selection is guided by three main criteria:

- **City types**: Including all four urban development pathways (Fig.1) acknowledges the different challenges and capacities to act upon climate change, such as mitigation priorities or planning strategies, which influence climate and sustainability outcomes.
- **Regional representation**: All seven IPCC regions (Africa, Asia, Europe, North America, South America, Oceania, and cross-regional) are covered, with a minimum of five cities per small region to ensure inclusion. Ensuring coverage across regions promotes geographic equity, recognizing that urban dynamics and vulnerabilities differ widely across continents.
- **Population shares**: Cities were sampled in proportion to the population of the cities living in the combination of regions and types, allowing the IPCC report to provide actionable insights where it matters. By weighting selection according to population shares, the sample captures the scale and demographic significance of urban centers, providing insights that are relevant to where most people live.

We focused the selection on 500 cities, allowing for sufficient flexibility and in-depth reviewing, for instance, even if no studies were identified for some cities in our database. This allows the authors of the report to make the decision, whether or not it is adequate to search for additional studies beyond what is available in our database. The selection involved four steps:

1. We grouped all cities into seven IPCC regions using the regional definitions of the IPCC AR6 continental regions[1].
2. We attributed the cities, their main type, based on 30 different clustering runs (we stopped at 30 runs as our statistics indicated that additional runs would not change the results markedly).
3. Steps one and two yielded a 7 x 4 matrix. For each cell, we computed the share of the global urban population (Fig. 2). Based on this share, we distributed the selection of the 500 cities proportionately. As a perfectly population-commensurate representation of the selected cities would lead smaller regions to be left out of the sample entirely, we ensured that at least five cities represent each small region.

[1] For the continental boundaries, see https://github.com/IPCC-WG1/Atlas/tree/main/reference-regions [last accessed 4.8.25]

4. We selected the cities representative of each type, meaning with the largest probability of belonging to a given type in each cell, based on the number of cities that were allocated to each cell in the 7 x 4 matrix. This means that these cities were consistently attributed to the same type across different model runs, representing the extent to which each city belongs to a given type.

This selection procedure, based on the region, city type, and population rather than the number of studies, helps to reflect the distribution of urban populations globally rather than the biases in the literature.

Results: Selected cases and global distribution of population, cities, and studies across city types and world regions. Figure 2 provides a detailed overview of the entire urban population, cities, and the number of studies distributed across the four city types and the seven world regions (in brown) and the selected case cities and associated studies (in blue).

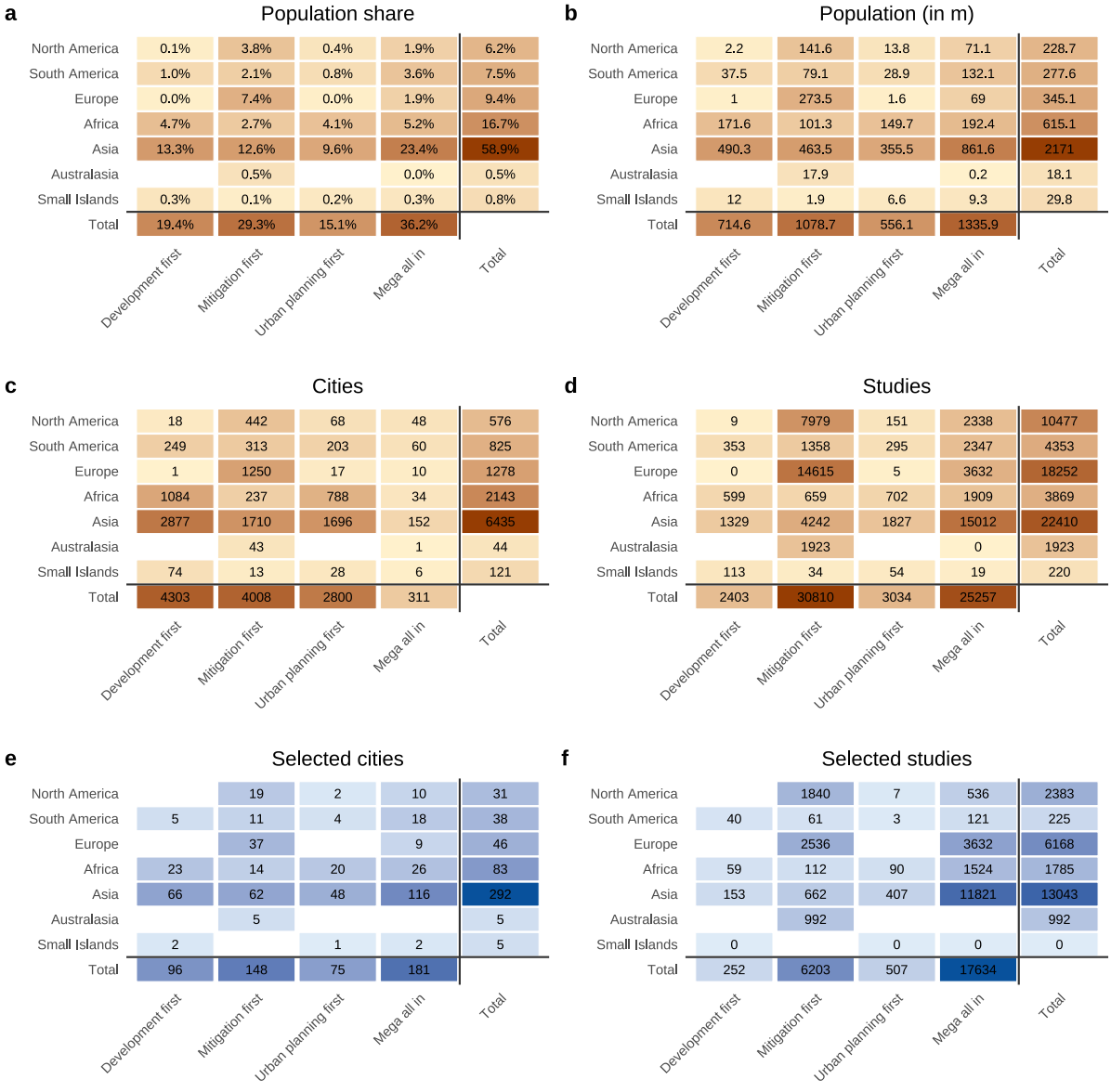

Figure 2: Distribution of the four types across the 7 world regions (according to IPCC AR6 definitions) across all cities (a-d) in brown color scales, and the selection of city cases (e-f).

Panels a and b show total population and population share, revealing that Asia dominates both metrics across all types. Overall, 59% of the urban population lives in Asia, followed by Africa (17%) and Europe (10%). Panels c and d illustrate the total number of cities and studies per cluster-region, highlighting that Asia and Africa have the largest numbers of cities and research studies, respectively, while Europe and North America feature prominently in Mitigation First studies.

Panels e and f focus on the subset of selected cities and studies using the procedure outlined above, showing that despite representing a manageable set of cities for in-depth reviews, the sample still maintains broad geographic and typological coverage, with careful attention to ensuring even smaller regions and less-represented types are included. This balanced coverage is crucial for enhancing the representativeness of the IPCC case selection, addressing known biases such as the overrepresentation of large cities and heavily studied regions, and supporting comprehensive expert review. We hope that our recommendation enables enough flexibility as well as a broad, comprehensive, and balanced coverage of the relevant evidence to achieve the biggest possible impact for climate action where it matters most.

Reference

Montfort, S., Callaghan, M., Creutzig, F., Lamb, W. F., Lu, C., Repke, T., Ge, K. & Minx, J. (2025). Systematic global stocktake of over 50,000 urban climate change studies. *Nature Cities*, 1-13.